## REMARKS

Applicant respectfully requests that the foregoing amendments be made prior to examination of the present application, and respectfully requests reconsideration of the present application in view of the foregoing amendments and the reasons that follow.

This amendment adds, changes and/or deletes claims in this application. Claims 7, 20 and 23 and the specification have been amended as suggested by the examiner. Claims 26-30 have been added, based on paragraphs 0017, 0045, 0050, 0068, and 0071, for example. A detailed listing of all claims that are, or were, in the application, irrespective of whether the claim(s) remain under examination in the application, is presented, with an appropriate defined status identifier. The amendment also changes portions of the specification, and marked up paragraphs are provided.

Claims 7 and 17 are rejected under the second paragraph of Section 112 as being indefinite. Claims 7 and 17 and the specification have been amended to refer to group 3B of the Periodic Table, as suggested.

Claims 1-19, 21, 22, 24 and 25 are rejected under Section 103(a) based on Raychaudhuri *et al.* (U.S. 6,551,725). The examiner urges that

> Raychaudhuri *et al.* discloses organic light-emitting diode devices comprising inorganic buffer structures. The OLED comprises a substrate, anode, emissive layer, a buffer structure comprising at least two layers and a sputtered metal or metal alloy as the cathode (see abstract). The device comprises a first buffer layer of alkaline halide and a second buffer layer of metal or metal alloy (see abstract). Although Raychaudhuri *et al.* does not exemplify multiple layers of the first buffer layer and the second buffer layer, Raychaudhuri *et al.* does teach the devices comprise "at least two layers". It would have been obvious to one of ordinary skill in the art at the time of the invention to have formed multiple layers of

> each of the first buffer layer and second buffer layer, because Raychaudhuri *et al.* teaches more than one of each may be present and it is obvious to combine materials useful for the same purpose. Raychaudhuri *et al.* teaches the bilayer is preferably greater than 0 and less than 30 nm (see col. 6, lines 51-54). Accordingly, multiple layers of buffer layer 1 and buffer layer 2 would meet the thickness requirements of claims 2, 12, 21, 22, 24 and 25, Furthermore, buffer layer 1 may be no greater than 10 nm (see col. 6, lines 29-30) and buffer layer 2 may be less than 20 nm but greater than 0 nm (see col. 6, lines 49-51). These limitations fall within the thickness ratios of claims 3, 4, 13, and 14. Preferred material for buffer layer 1 includes LiF (see col. 6, lines 24-25) per claims 6 and 16. The metals of buffer layer 2 have work functions between 2.0 eV and 4.0 eV per claims 5 and 15 (see col. 6, lines 35-36). Raychaudhuri *et al.* teaches metals for buffer layer 2 (see col. 6, lines 32-35) that have electronegativity values within the range recited in claims 8 and 18 (for example, on the Pauling scale, gallium has an electronegativity value of 1.81 and sodium has a value of 0.93). With regard to the method claims, sputtering is taught as the means by which the cathode is formed (see Examples and col. 3, lines 45-47).
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> Emphasis in original.

The key to the examiner's case is the allegation that the statement in Raychaudhuri *et al.* that there are at least two buffer layers would have suggested to one of ordinary skill in the art at the time of the invention to have formed multiple layers of each of the first buffer layer and second buffer layer. However, Raychaudhuri does not teach that multiples of the same two buffer layers are intended. The disclosure in Raychaudhuri of "at least two buffer layers" could just as well suggest the use of additional buffer layers of other materials, or an additional buffer layer of just one of the two buffer layers, instead of two or more first buffer layers and two or more second buffer layers, as presently claimed.

The Japanese counterpart of Raychaudhuri is discussed in the background of applicant's specification, which notes that:

> Japanese Unexamined Patent Application Publication No. 2002-260862 discloses providing a first buffer layer of alkali halide and second buffer layer of a metal with low work function on an organic EL layer, in order to reduce damage to the organic EL layer due to sputtering. According to this document, the buffer layer with this structure enhances electron injection efficiency, reduces damage due to sputtering, and enhances optical transmissivity. Total thickness of the buffer layers is stated to be preferably less than 5 nm. The cathode (top electrode) disclosed in an embodiment in this document is a metal electrode such as silver or aluminum, which is not suited for application to a top emission type organic EL device.

A comparison to as much as Raychaudhuri shows in a concrete embodiment is provided in applicant's specification. Thus, Comparative Example 1 relates to buffer layer structure comprising a LiF layer 5 nm thick and an aluminum layer 5 nm thick at a deposition rate of 2.5 Å/s. The buffer structure consisted of two layers and had a total thickness of 10 nm. Comparative Example 2 relates to buffer layer structure comprising a LiF layer 1 nm thick and an aluminum layer 5 nm thick at a deposition rate of 2.5 Å/s. The buffer structure consisted of two layers and had a total thickness of 10 nm. This was compared to a lamination of 10 buffer layers (5 first buffer layers and 5 second buffer layers) in accordance with the present invention. The result was shown in Table 2:

| | construction | number of layers | transmission rate (500 nm) |
|---|---|---|---|
| Example 1 | (LiF 1.0 nm / Al 1.0 nm) x 5 | 10 | 65% |
| Comp Ex 1 | LiF 5.0 nm / Al 5.0 nm | 2 | 45% |
| Comp Ex 2 | LiF 1.0 nm / Al 5.0 nm | 2 | 40% |

As apparent from the Table 2, a multilayered buffer structure as in Example 1 exhibits a higher transmission rate than a single layer buffer structure (Comparative Example 1 or 2). Comparing the buffer structures having the equal total aluminum thickness (Comparison between Example 1 and Comparative Example 2), a multilayered buffer structure consisting of alternately laminated metallic layers and transparent material layers according to the invention exhibits higher transmission rate than a buffer structure having a single metallic layer. This result could not have been predicted based on the disclosure in Raychaudhuri.

Next, an IZO top electrode was sputtered onto a device that included layers as described in Example 1 and Comparative Examples 1 and 2. The results were shown in Table 3:

| | buffer structure | cathode material | current density (A/cm) | luminance ($cd/m^2$) | voltage (V) |
|---|---|---|---|---|---|
| Example 2 | (LiF 1.0 nm / Al 1.0 nm) x 5 | IZO | $1 \times 10^{-2}$ | 618 | 6.23 |
| Comp Ex 3 | LiF 5.0 nm / Al 5.0 nm | IZO | $1 \times 10^{-2}$ | 464 | 10.60 |
| Comp Ex 4 | LiF 1.0 nm / Al 5.0 nm | IZO | $1 \times 10^{-2}$ | 445 | 6.05 |

As shown in Table 3, the organic EL devices having a multilayered buffer structure according to the present invention (Example 2) exhibits superior performance to the organic EL devices having a buffer structure that is not a multilayer structure (Comparative Examples 3 and 4). The buffer layer according to the invention has increased its thickness while preserving sufficient transmissivity and conductivity. Moreover, the buffer layer of the invention has effectively mitigated damage that would be inflicted on the organic EL layer by sputtering using an oxide target.

These results are consistent with applicant's discussion of Raychaudhuri in the background of their specification:

> If the top electrode (cathode) is formed of a transparent conductive film of, for example, IZO by sputtering, damage on the organic EL layer is more severe than in the case of a top electrode of a metallic electrode. Consequently, the total thickness of the buffer layers of about 5 nm is insufficient to protect against the impact of sputtering, although improvement may be possible in electron injection efficiency and in optical transmission rate. Even if the thickness of the buffer layers is increased, desirable organic EL characteristics are difficult to obtain because the resistance to sputtering impact and optical transmissivity are in a trade-off relationship.

The use of top electrodes of ITO or IZO causes a greater problem with sputter damage than is the case when the top electrode is a metallic electrode, and this is borne out by the results presented in applicant's specification. Raychaudhuri teaches a top electrode of a metal or metal alloy, more particularly a silver electrode, and thus does not teach a problem that is solved by the present invention, namely the greater sputter damage that occurs when ITO or IZO top electrodes are sputtered. Therefore, Raychaudhuri does not suggest that the problem can be solved by using a buffer layer arrangement as presently claimed, and this is more particularly claimed in newly presented claims 26, 27, 28 and 30 which recite a top electrode of ITO or IZO.

The doctrine of unexpected results requires that the claimed invention be compared to the closest embodiment of the prior art, not all possible embodiments, as asserted in the Office Action. In re Johnson, 223 U.S.P.Q. 1260 (Fed. Cir. 1984). Applicants have satisfied this requirement. Accordingly, the present claims should be in *prima facie* condition for allowance.

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested. The Examiner is invited to contact the undersigned by

telephone if it is felt that a telephone interview would advance the prosecution of the present application.

If there are any problems with this response, Applicant's attorney would appreciate a telephone call. In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,

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6/30/05
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